PATENT ABSTRACTS OF JAPAN

(11)Publication number :   2001-317389

(43)Date of publication of application : 16.11.2001

(51)Int.Cl.	F02D 41/04
	F02D 17/00
	F02D 29/02
	F02M 55/02

(21)Application number : 2000-136046

(22)Date of filing :   09.05.2000

(71)Applicant : TOYOTA MOTOR CORP

(72)Inventor : YAMAZAKI DAICHI
KURATA NAOKI
SUGIYAMA MASANORI

(54) CYLINDER INJECTION TYPE INTERNAL COMBUSTION ENGINE CONTROLLER

(57)Abstract:

PROBLEM TO BE SOLVED: To provide a cylinder injection type internal combustion engine controller capable of maintaining sufficient fuel pressure for compression stroke injection for a long time even if an internal combustion engine stops due to automatic stop and increasing the frequency of compression stroke injection after automatic start.

SOLUTION: In a flag XPREEC = 'ON' just before automatic stop ('NO' at S220), a fuel pressure P is increased just before automatic stop as control duty DT=100(%) of a solenoid spill valve (S23). For this reason, it takes a long time until the fuel pressure is reduced down to such extent that fuel cannot be properly injected into a combustion chamber in a compression stroke because the fuel pressure reduction is started from a high fuel pressure P even if an engine stops. Consequently, a possibility for compression stroke injection immediately after automatic start is increased, and the frequency of compression stroke injection is increased to improve fuel economy sufficiently.
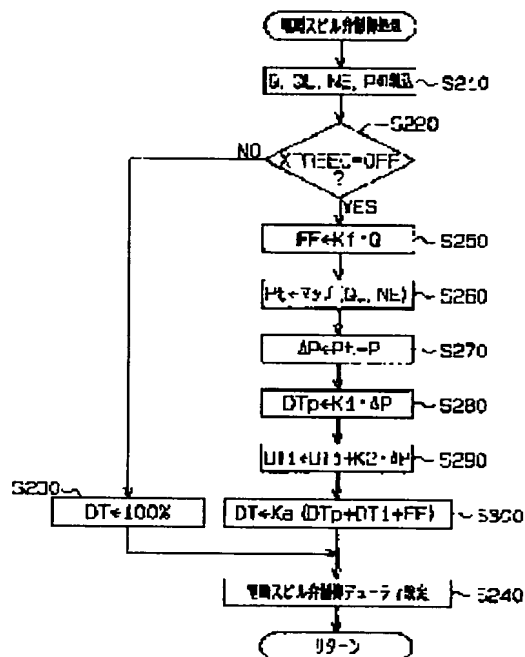
LEGAL STATUS

[Date of request for examination]   01.04.2004

[Date of sending the examiner's decision of rejection]

[Kind of final disposal of application other than the examiner's decision of rejection or application converted registration]

[Date of final disposal for application]

[Patent number]

[Date of registration]

[Number of appeal against examiner's decision of rejection]

[Date of requesting appeal against examiner's decision of rejection]

[Date of extinction of right]

THIS PAGE BLANK (USPTO)

* NOTICES *

JPO and NCIPI are not responsible for any
damages caused by the use of this translation.

1.This document has been translated by computer. So the translation may not reflect the original precisely.
2.**** shows the word which can not be translated.
3.In the drawings, any words are not translated.

CLAIMS

[Claim(s)]
[Claim 1] During operation of the cylinder-injection-of-fuel type internal combustion engine which lights the gaseous mixture which produced the fuel fed from the fuel pump from the fuel injection valve by injecting directly into a combustion chamber with an ignition plug When this internal combustion engine's operational status satisfies automatic-stay conditions, an internal combustion engine is stopped automatically. The cylinder-injection-of-fuel type internal combustion engine control unit characterized by having a fuel pressure-up means to be the cylinder-injection-of-fuel type internal combustion engine control unit which carries out automatic start up of the operation of an internal combustion engine when automatic start-up conditions are satisfied, and to raise the fuel pressure by the side of a fuel injection valve just before said automatic stay.
[Claim 2] When said fuel pressure-up means adjusts the pumping speed of said fuel pump to max in a configuration according to claim 1 just before said automatic stay, it is the cylinder-injection-of-fuel type internal combustion engine control unit characterized by raising the fuel pressure by the side of a fuel injection valve.
[Claim 3] It is the cylinder-injection-of-fuel type internal combustion engine control unit characterized by raising the fuel pressure by the side of a fuel injection valve so that said relief valve may open temporarily by adjusting the pumping speed of between the pressure-up durations in which said fuel pressure-up means was formed just before said automatic stay while having the relief valve which will open if the fuel pressure by the side of a fuel injection valve becomes in a configuration according to claim 2 more than a setting-out injection-valve opening pressure, and discharges a fuel injection valve side to a fuel, and said fuel pump to max.
[Claim 4] It is the cylinder-injection-of-fuel type internal combustion engine control unit characterized by raising the fuel pressure by the side of a fuel injection valve by amending the target fuel pressure according to an internal combustion engine's operational status [in / in a configuration according to claim 1, it has a fuel-pressure control means to adjust the fuel pressure by the side of a fuel injection valve to the target fuel pressure according to an internal combustion engine's operational status, by adjustment of the pumping speed of said fuel pump, and / to just before said automatic stay / in said fuel pressure-up means / said fuel-pressure control means] to a boost side.
[Claim 5] It is the cylinder-injection-of-fuel type internal combustion engine control unit characterized by said fuel pressure-up means raising the fuel pressure by the side of a fuel injection valve just before said automatic stay more than the setting-out injection-valve opening pressure of said relief valve while having the relief valve which will open in a configuration according to claim 1 or 4 if the fuel pressure by the side of a fuel injection valve becomes more than a setting-out injection-valve opening pressure, and discharges a fuel from a fuel injection valve side.
[Claim 6] It is the cylinder-injection-of-fuel type internal combustion engine control unit characterized by making the processing which raises fuel pressure between pressure-up durations more than the setting-out injection-valve opening pressure of said relief valve continue after said fuel pressure-up means raises fuel pressure in a configuration according to claim 5 just before said automatic stay more than the setting-out injection-valve opening pressure of said relief valve.

[Translation done.]

THIS PAGE BLANK (USPTO)

DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Field of the Invention] This invention relates to the cylinder-injection-of-fuel type internal combustion engine control unit which lights the gaseous mixture which produced the fuel fed from the fuel pump from the fuel injection valve by injecting directly into a combustion chamber with an ignition plug. Especially, when an internal combustion engine's operational status satisfies automatic-stay conditions during operation of a cylinder-injection-of-fuel type internal combustion engine, an internal combustion engine is stopped automatically, and when automatic start-up conditions are satisfied, it is related with the cylinder-injection-of-fuel type internal combustion engine control unit which carries out automatic start up of the operation of an internal combustion engine.
[0002]
[Description of the Prior Art] When an internal combustion engine is in a low loading condition like at the time of an idle conventionally, while realizing lean combustion and reconciling reduction of high power and fuel consumption, the cylinder-injection-of-fuel type internal combustion engine which reduces the displacement of a carbon dioxide etc. is known (JP,10-299543,A). In such a cylinder-injection-of-fuel type internal combustion engine, in order to make gaseous mixture light certainly in the time of lean combustion, fuel injection is performed at the time of a compression stroke, it changes into the condition that the deep fuel stratified to the circumference of an ignition plug, and stratification combustion which carries out ignition combustion is performed. And in burning in theoretical air fuel ratio, fuel injection is performed in an intake stroke and it is performing homogeneity combustion burn the condition that the fuel distributed to homogeneity in the whole combustion chamber, by carrying out.
[0003] Moreover, in the automobile engine, when an automobile carries out a transit halt at a crossing etc. for an improvement of fuel consumption etc., an internal combustion engine is stopped automatically, and the automatic-stay starting system which rotates a starter, and automatic start up of the internal combustion engine is carried out [starting system], and enables start of an automobile at the time of start actuation, and the so-called economy running system are known (JP,10-47104,A).
[0004] Therefore, it is expected by combining the above-mentioned automatic-stay starting system to the cylinder-injection-of-fuel type internal combustion engine which mentioned above that an improvement of much more fuel consumption will be made.
[0005]
[Problem(s) to be Solved by the Invention] By the way, from the need of injecting a fuel to a high-pressure combustion chamber, by the cylinder-injection-of-fuel type internal combustion engine, a fuel is high-voltage-ized with a high voltage fuel pump, and it is feeding to the fuel injection valve side by the fuel injection at the time of the compression stroke in a cylinder-injection-of-fuel type internal combustion engine.
[0006] However, when such a cylinder-injection-of-fuel type internal combustion engine is made to stop automatically with automatic-stay starting system, since a high voltage fuel pump also stops, a high voltage fuel is no longer supplied to a fuel injection valve side between automatic stays. For this reason, even if the fuel injection valve side including a fuel line is sealed, when a fuel leaks gradually, while the fuel pressure by which pressure accumulation was carried out stops automatically, it will fall.
[0007] Then, if automatic start up is carried out, actuation of a fuel pump will be started. It cannot but stop however, performing homogeneity combustion which performs fuel injection also with low fuel pressure in the intake stroke in which good injection is possible, when having become fuel pressure inadequate for the fuel injection at the time of a compression stroke by fuel pressure lowering under automatic stay mentioned above until fuel pressure is fully recovered. For this reason, even if the operational status of internal combustion engines other than fuel pressure suits the condition in which stratification combustion is possible at the time of automatic start up, in order to have to perform homogeneity combustion, there is a possibility that the improvement in fuel consumption etc. may become less enough.
[0008] This invention maintains sufficient fuel pressure over a long period of time to compression stroke injection, even if an internal combustion engine stops by automatic stay, and it aims at offer of the cylinder-injection-of-fuel type internal combustion engine control unit which can raise the frequency of the compression stroke injection after automatic start up.
[0009]
[Means for Solving the Problem] Hereafter, the means and its operation effectiveness for attaining the above-mentioned object are indicated. A cylinder-injection-of-fuel type internal combustion engine control unit according

to claim 1 During operation of the cylinder-injection-of-fuel type internal combustion engine which lights the gaseous mixture which produced the fuel fed from the fuel pump from the fuel injection valve by injecting directly into a combustion chamber with an ignition plug When this internal combustion engine's operational status satisfies automatic-stay conditions, an internal combustion engine is stopped automatically. When automatic start-up conditions are satisfied, it is the cylinder-injection-of-fuel type internal combustion engine control unit which carries out automatic start up of the operation of an internal combustion engine, and it is characterized by having a fuel pressure-up means to raise the fuel pressure by the side of a fuel injection valve just before said automatic stay.

[0010] The fuel pressure-up means is raising the fuel pressure by the side of a fuel injection valve just before automatic stay. For this reason, even if a cylinder-injection-of-fuel type internal combustion engine stops automatically and a high voltage fuel is no longer fed from a fuel pump after that, as compared with the case where it stops like before with the usual fuel pressure condition, from high fuel pressure, it will fall gradually and will go. For this reason, by the time it falls to the fuel pressure suitable fuel injection becomes impossible to a combustion chamber by the compression stroke, the allowances of an engine halt of long duration will arise.

[0011] Therefore, the probability to maintain sufficient fuel pressure for the fuel injection at the time of a compression stroke immediately after future automatic start up increases. By this, after automatic start up, if an internal combustion engine is the operational status in which stratification combustion is possible, compression stroke injection can be performed promptly, and stratification combustion can be performed. Therefore, the frequency of the compression stroke injection after automatic start up can be raised, and the improvement in fuel consumption etc. can fully be attained.

[0012] Said fuel pressure-up means is characterized by raising the fuel pressure by the side of a fuel injection valve, when a cylinder-injection-of-fuel type internal combustion engine control unit according to claim 2 adjusts the pumping speed of said fuel pump to max in a configuration according to claim 1 just before said automatic stay.

[0013] Thus, fuel pressure can be made to reach sufficient high voltage condition promptly by making pumping speed of a fuel pump into max. For this reason, the frequency of the compression stroke injection after automatic start up increases further, and becomes much more effective [a fuel consumption improvement etc.].

[0014] A cylinder-injection-of-fuel type internal combustion engine control unit according to claim 3 While having the relief valve which will open in a configuration according to claim 2 if the fuel pressure by the side of a fuel injection valve becomes more than a setting-out injection-valve opening pressure, and discharges a fuel from a fuel injection valve side Said fuel pressure-up means is a cylinder-injection-of-fuel type internal combustion engine control unit characterized by raising the fuel pressure by the side of a fuel injection valve so that said relief valve may open temporarily by adjusting the pumping speed of said fuel pump to max between the pressure-up durations prepared just before said automatic stay.

[0015] Thus, a fuel pressure-up means raises fuel pressure by adjusting the pumping speed of a fuel pump to max between pressure-up durations, and is making the relief valve open temporarily just before automatic stay. By this, the opportunity of disconnection of the relief valve which does not usually almost have the opportunity opened can be prepared.

[0016] For this reason, the frequency of the compression stroke injection after automatic start up can be raised, and, in addition to fully attaining the improvement in fuel consumption etc., fixing by a relief valve not being opened for a long period of time, plugging by the foreign matter, etc. can be prevented.

[0017] Furthermore, the fuel temperature by the side of a fuel injection valve can be reduced just before automatic stay by setting up a pressure-up duration for a long time, feeding the high voltage fuel of a large quantity to a fuel injection valve side, and making it discharge from a relief valve. For this reason, during an internal combustion engine's automatic stay, the temperature of a fuel will follow on going up and maintenance of the fuel pressure by thermal expansion will be performed. From this, the frequency of the compression stroke injection after automatic start up can be raised further, and the improvement in fuel consumption etc. can be attained more effectively.

[0018] A cylinder-injection-of-fuel type internal combustion engine control unit according to claim 4 In a configuration according to claim 1 by adjustment of the pumping speed of said fuel pump It has a fuel-pressure control means to adjust the fuel pressure by the side of a fuel injection valve to the target fuel pressure according to an internal combustion engine's operational status. Said fuel pressure-up means It is characterized by raising the fuel pressure by the side of a fuel injection valve by amending the target fuel pressure according to an internal combustion engine's operational status in said fuel-pressure control means to a boost side just before said automatic stay.

[0019] When the fuel-pressure control means is adjusting fuel pressure to the target fuel pressure according to an internal combustion engine's operational status by adjustment of the pumping speed of a fuel pump, a fuel pressure-up means can raise fuel pressure by amending the target fuel pressure according to an internal combustion engine's operational status in a fuel-pressure control means to a boost side just before automatic stay.

[0020] Fuel pressure higher than the usual fuel pressure which the fuel-pressure control means is adjusting is realized by this just before automatic stay. Therefore, by the time it falls to the fuel pressure in which the fuel injection to a combustion chamber is impossible at the time of a compression stroke, the allowances of an engine halt of long duration will arise rather than usual.

[0021] For this reason, the probability to maintain sufficient fuel pressure for the fuel injection at the time of a compression stroke immediately after future automatic start up will increase. Therefore, the frequency of the compression stroke injection after automatic start up can be raised, and the improvement in fuel consumption etc.

can fully be attained.

[0022] While having the relief valve which a cylinder-injection-of-fuel type internal combustion engine control unit according to claim 5 will open in a configuration according to claim 1 or 4 if the fuel pressure by the side of a fuel injection valve becomes more than a setting-out injection-valve opening pressure, and discharges a fuel from a fuel injection valve side, said fuel pressure-up means is characterized by raising the fuel pressure by the side of a fuel injection valve just before said automatic stay more than the setting-out injection-valve opening pressure of said relief valve.

[0023] A fuel pressure-up means raises fuel pressure just before automatic stay more than the setting-out injection-valve opening pressure of the relief valve with which the fuel injection valve side was equipped. By this, the opportunity of disconnection of the relief valve which does not usually almost have the opportunity opened can be prepared.

[0024] For this reason, the frequency of the compression stroke injection after automatic start up can be raised, and, in addition to fully attaining the improvement in fuel consumption etc., fixing by a relief valve not being opened for a long period of time, plugging by the foreign matter, etc. can be prevented.

[0025] A cylinder-injection-of-fuel type internal combustion engine control unit according to claim 6 is characterized by said fuel pressure-up means making the processing which raises fuel pressure between pressure-up durations more than the setting-out injection-valve opening pressure of said relief valve continue, after raising fuel pressure just before said automatic stay more than the setting-out injection-valve opening pressure of said relief valve in a configuration according to claim 5.

[0026] Thus, a fuel pressure-up means is making the processing which raises fuel pressure more than the setting-out injection-valve opening pressure of a relief valve continue between pressure-up durations, even after raising fuel pressure more than the setting-out injection-valve opening pressure of a relief valve. Thus, a fuel can be fed and a large quantity can be made to discharge from a relief valve to a fuel injection valve side by opening a repeat relief valve continuously between pressure-up durations just before automatic stay. For this reason, in addition to raising the frequency of the compression stroke injection after automatic start up, and fully attaining the improvement in fuel consumption etc., fixing by a relief valve not being opened for a long period of time, plugging by the foreign matter, etc. can be prevented.

[0027] Furthermore, the fuel temperature by the side of a fuel injection valve can be reduced just before automatic stay by the ability feeding the high voltage fuel of a large quantity to a fuel injection valve side, and making it discharge from a relief valve by setting up a pressure-up duration. For this reason, during an internal combustion engine's automatic stay, the temperature of a fuel will follow on going up and maintenance of the fuel pressure by thermal expansion will be performed. From this, the frequency of the compression stroke injection after automatic start up can be raised further, and the improvement in fuel consumption etc. can be attained more effectively.

[0028]

[Embodiment of the Invention] [Gestalt 1 of operation] drawing 1 expresses the outline configuration of the cylinder-injection-of-fuel type internal combustion engine with which invention mentioned above was applied. Drawing 2 expresses the block diagram of the control system of this cylinder-injection-of-fuel type internal combustion engine.

[0029] The gasoline engine (it abbreviates to an "engine" hereafter) 2 as a cylinder-injection-of-fuel type internal combustion engine is carried in the automobile car as an object for automobile actuation. This engine 2 has six cylinder 2a. As shown also in drawing 3 - drawing 6 , the combustion chamber 10 divided by the piston 6 which reciprocates within a cylinder block 4 and a cylinder block 4, and the cylinder head 8 attached on the cylinder block 4 is formed in each cylinder 2a, respectively.

[0030] And the exhaust valve 16 of 1st inlet-valve 12a, 2nd inlet-valve 12b, and a couple is formed in each combustion chamber 10, respectively. 1st inlet-valve 12a is connected to 1st inlet port 14a among this, 2nd inlet-valve 12b is connected to 2nd inlet port 14b, and the exhaust valve 16 of a couple is connected to the exhaust port 18 of a couple, respectively.

[0031] Drawing 3 is the horizontal sectional view of the cylinder head 8 for 1 cylinder, and 1st inlet port 14a and 2nd inlet port 14b are straight-way-type inlet ports which extend in the shape of an abbreviation straight line so that it may be illustrated. Moreover, the ignition plug 20 is arranged in the center section of the internal surface of the cylinder head 8. Furthermore, the fuel injection valve 22 is arranged at the internal-surface periphery of the cylinder head 8 1st inlet-valve 12a and near the 2nd inlet-valve 12b so that a direct fuel can be injected in a combustion chamber 10.

[0032] In addition, a X-X sectional view [in / drawing 4 , and / in drawing 5 / drawing 3] and drawing 6 are the Y-Y sectional views in drawing 3 . [the top view of the top face of a piston 6] The crevice 24 which has the profile configuration of the dome shape prolonged from the lower part of a fuel injection valve 22 to the lower part of an ignition plug 20 is formed in the top face of the piston 6 formed in abbreviation Yamagata so that it might be illustrated.

[0033] As shown in drawing 1 , 1st inlet port 14of each cylinder 2a a is connected to the surge tank 32 through 1st inhalation-of-air path 30a formed in the inlet manifold 30. Moreover, 2nd inlet port 14b is connected with the surge tank 32 through 2nd inhalation-of-air path 30b. In this and each 2nd inhalation-of-air path 30b, the air-current control valve 34 is arranged, respectively. While connecting through the common shaft 36, closing motion actuation of these air-current control valves 34 is carried out by the negative pressure type actuator 37 through this shaft 36. In addition, when the air-current control valve 34 is made into a closed state, the turning style S strong in a

combustion chamber 10 (drawing 3) arises by the inhalation of air inhaled only from 1st inlet port 14a.

[0034] The surge tank 32 is connected with the air cleaner 42 through the air intake duct 40. In the air intake duct 40, the throttle valve 46 driven by the motor 44 (a DC motor or step motor) is arranged. The opening (throttle opening TA) of this throttle valve 46 is detected by throttle opening sensor 46a, and opening control of the throttle valve 46 is carried out according to operational status. Moreover, each exhaust port 18 of each cylinder 2a is connected with the exhaust manifold 48. The exhaust manifold 48 purified exhaust air through the catalytic converter 49, and has discharged it outside.

[0035] The configuration of the fuel feed system which supplies a high voltage fuel to drawing 7 at a fuel injection valve 22 side is shown. It has connected with the fuel injection valve 22 which the fuel distribution tube 50 is formed in the cylinder head 8 1st inlet-valve 12a and near the 2nd inlet-valve 12b so that it may illustrate, and is prepared in each cylinder 2a. The fuel supplied from the fuel distribution tube 50 is injected in the direct combustion chamber 10 from a fuel injection valve 22.

[0036] The fuel distribution tube 50 which has distributed the fuel to the fuel injection valve 22 is connected to the high voltage fuel pump 54 through high voltage fuel path 54a. In addition, check-valve 54b which regulates that a fuel flows backwards is prepared in the high voltage fuel pump 54 side from the fuel distribution tube 50 at high voltage fuel path 54a. The feed pump 58 prepared in the fuel tank 56 through low voltage fuel path 54c is connected to the high voltage fuel pump 54.

[0037] A feed pump 58 sends out a fuel to gallery 54i of the high voltage fuel pump 54 through filter 58a and pressure regulator 58b by attracting the fuel in a fuel tank 56 and carrying out the regurgitation to the low voltage fuel path 54c side.

[0038] the revolution of cam 2c for pumps which the high voltage fuel pump 54 was attached in the cylinder head cover (graphic display abbreviation) which has covered the upper part of the cylinder head 8, and was prepared in the object for the inlet valves of an engine 2, or cam-shaft 2b for exhaust valves — pump cylinder 54d — inner plunger 54e is made to reciprocate By reciprocation of this plunger 54e, a fuel is inhaled [like the inhalation line in which the volume of 54f of high voltage pump houses increases] through gallery 54i from the low voltage fuel path 54c side in 54f of high voltage pump houses. And in the application-of-pressure stroke in which the volume of 54f of high voltage pump houses decreases, the fuel pressurized at 54f of high voltage pump houses is fed to the fuel distribution tube 50 side through high voltage fuel path 54a to required timing.

[0039] the high voltage fuel pump 54 — the interior — electromagnetism — the spill valve 55 is formed. this electromagnetism — the spill valve 55 is a closing motion valve which performs free passage cutoff between gallery 54i and 54f of high voltage pump houses. electromagnetism — when the spill valve 55 is opening, gallery 54i and 54f of high voltage pump houses are open for free passage. For this reason, even if the fuel inhaled in 54f of high voltage pump houses serves as an application-of-pressure stroke, overflow of it will be carried out to the low voltage fuel path 54c side through gallery 54i. Therefore, a fuel is not high-voltage-ized and is not fed through high voltage fuel path 54a at the fuel distribution tube 50 side.

[0040] on the other hand, electromagnetism — when the spill valve 55 closes the valve, between gallery 54i and 54f of high voltage pump houses is intercepted. For this reason, in an application-of-pressure stroke, overflow of the fuel in 54f of high voltage pump houses is not carried out to gallery 54i, and it is high-voltage-ized by compression of plunger 54e. As for an aperture and a high voltage fuel, check-valve 54b is fed by this through high voltage fuel path 54a to the fuel distribution tube 50 side.

[0041] the electromagnetism which mentioned above the electronic control unit ("ECU" is called hereafter) 60 with reference to the fuel oil consumption Q separately controlled by the fuel pressure P and ECU60 detected in fuel-pressure sensor 50a attached in the fuel distribution tube 50 — the closing motion valve timing of the spill valve 55 is controlled. By this, ECU60 can adjust the fuel pressure feed ratio from the high voltage fuel pump 54 to the fuel distribution tube 50 side, and can adjust the fuel pressure P in the fuel distribution tube 50 to a required pressure.

[0042] In addition, 54h of blowdown paths equipped with 54g of relief valves is connected to the fuel distribution tube 50. If the fuel pressure P in the fuel distribution tube 50 becomes more excessive than a setting-out injection-valve opening pressure by a superfluous fuel being supplied to the fuel distribution tube 50 side, 54g of relief valves will open, they will discharge a superfluous fuel to 54h side of blowdown paths, and will maintain the fuel pressure in the fuel distribution tube 50 below to a setting-out injection-valve opening pressure. In addition, the fuel discharged to 54h side of blowdown paths is returned to the gallery 54i side. Thus, this fuel feed system is formed as a fuel-supply system of return loess by which the superfluous fuel by the side of the fuel distribution tube 50 is not returned to the direct fuel tank 56.

[0043] In addition, in the fuel-supply system of this return loess, when a fuel is returned to 54h of blowdown paths from the fuel distribution tube 50 side, the fuel pressure put on low voltage fuel path 54c from 54h of blowdown paths tends to rise. Thus, if the fuel pressure of a low voltage system tends to rise, pressure regulator 58b in a fuel tank 56 will open. A fuel to the extent that it was pumped up from the fuel tank 56 with the fuel 58 which exists near the pressure regulator 58b, i.e., a feed pump, among the fuels which exist in low voltage fuel path 54c by this is returned in a fuel tank 56 from pressure regulator 58b. In this way, while fuel pressure lifting of the low voltage system applied to low voltage fuel path 54c from 54h of blowdown paths is prevented, since the fuel returned in a fuel tank 56 is a fuel to the extent that it was pumped up from the fuel tank 56, it can prevent the temperature rise in a fuel tank 56.

[0044] As shown in drawing 2 , ECU60 consisted of a digital computer and is equipped with CPU(microprocessor) 60b, ROM(read-only memory) 60c, RAM(random access memory) 60d mutually connected through bi-directional-bus

60a, backup RAM60e, 60f of input circuits, and 60g of output circuits.

[0045] Throttle opening sensor 46a which detects the throttle opening TA has inputted the output voltage proportional to the opening TA of a throttle valve 46 into 60f of input circuits. The accelerator opening sensor 76 was attached in the accelerator pedal 74, and the output voltage proportional to the amount ACCP of treading in of an accelerator pedal 74 is inputted into 60f of input circuits. The stop lamp switch 80 which detects the treading-in condition of a brake pedal 78 has inputted the stop-lamp-switch signal SLSW into 60f of input circuits. The rotational frequency sensor 82 generated the output pulse, whenever 30 degrees (graphic display abbreviation) of crankshafts rotated, and it has inputted this output pulse into 60f of input circuits. The cylinder distinction sensor 84 generated the output pulse, when the No. 1 cylinder of for example, the cylinder 2a reached an inhalation-of-air top dead center, and it has inputted this output pulse into 60f of input circuits. In CPU60b, the current crank angle was calculated from the output pulse of the cylinder distinction sensor 84, and the output pulse of the rotational frequency sensor 82, and the engine speed NE is calculated from the frequency of the output pulse of the rotational frequency sensor 82.

[0046] Moreover, the coolant temperature sensor 86 was formed in the cylinder block 4 of an engine 2, the circulating water temperature THW of an engine 2 was detected, and the output voltage according to a circulating water temperature THW is inputted into 60f of input circuits. The intake-pressure sensor 88 was formed in the surge tank 32, and the output voltage corresponding to the intake pressure PM in a surge tank 32 (the pressure of inhalation air: absolute pressure) is inputted into it at 60f of input circuits. The air-fuel ratio sensor 90 was formed in the exhaust manifold 48, and the output voltage Vox according to an air-fuel ratio is inputted into 60f of input circuits. Fuel-pressure sensor 50a prepared in the fuel distribution tube 50 has inputted the output voltage according to the fuel pressure P in the fuel distribution tube 50 into 60f of input circuits. The electrical potential difference VB of the dc-battery 92 carried is inputted into 60f of input circuits. Moreover, the speed sensor 94 was formed in the output side of transmission (graphic display abbreviation), and the signal according to the vehicle speed SPD is inputted into 60f of input circuits based on a revolution of the output shaft of transmission.

[0047] 60g of output circuits — each fuel injection valve 22, the negative pressure type actuator 37, the motor 44 for actuation of a throttle valve 46, and electromagnetism — it connects with the spill valve 55, an ignitor 100, and the starter motor 102, and actuation control of each actuator equipments 22, 37, 44, and 55,100,102 is carried out if needed.

[0048] Next, the fuel-injection control performed after the completion of start up in an engine 2 is explained. The processing which sets an operating system required for fuel-injection control as the flow chart of drawing 8 is shown. This processing is processing which is set up beforehand and which is periodically performed for every crank angle. In addition, each processing step in each flow chart explained below is expressed with "S-."

[0049] First, the fuel pressure P obtained from the amount ACCP of treading in of engine-speed NE obtained from the signal of the engine-speed sensor 82 and the accelerator pedal 74 obtained from the signal of the accelerator opening sensor 76 (an accelerator opening is called hereafter) and the signal of fuel-pressure sensor 50a is read into the working area which is RAM60d (S100).

[0050] Next, the Lean fuel oil consumption QL is computed based on an engine speed NE and the accelerator opening ACCP (S102). In case this Lean fuel oil consumption QL performs stratification combustion, it expresses the optimal fuel oil consumption for making the output torque of an engine 2 into demand torque. The Lean fuel oil consumption QL is beforehand calculated by experiment, and as shown in drawing 9 , it is memorized in ROM60c as a map which makes a parameter the accelerator opening ACCP and an engine speed NE. At step S102, the Lean fuel oil consumption QL is computed based on this map. In addition, since the numeric value is discretely arranged on the map, when the value which is in agreement as a parameter does not exist, it will ask by interpolation count. Calculation from the map by such interpolation is similarly performed, when calculating a required numeric value from maps other than the map described here.

[0051] Next, it is judged for the fuel pressure P currently surveyed whether it is more than the reference pressure Pc (S104). In order that this judgment may perform stratification combustion, it is for judging whether the fuel serves as the fuel pressure P which can enough be injected in the compression stroke.

[0052] If it is P>=Pc (it is "YES" at S104), since it is possible to fully carry out fuel injection in a compression stroke, based on the Lean fuel oil consumption QL and an engine speed NE, the operating system according to three fields RI, R2, and R3 as shown in the map of drawing 10 is set up (S106). In this way, this processing is once ended. In addition, the map of drawing 10 sets up a suitable operating system according to the Lean fuel oil consumption QL and an engine speed NE by experiment beforehand, and is memorized in ROM60c as a map which makes a parameter the Lean fuel oil consumption QL and an engine speed NE.

[0053] That is, as shown in drawing 10 , in a operating range R1 with the Lean fuel oil consumption QL and an engine speed NE smaller than a borderline QQ1, a method F1 is set up as an operating system, and the fuel of an amount according to the Lean fuel oil consumption QL is injected in the compression stroke last stage. The injection fuel by injection in this compression stroke last stage collides with the circumferential wall surface 26 (drawing 4 , 5) of a crevice 24, after running in the crevice 24 of a piston 6 from a fuel injection valve 22. It moves being made to evaporate the fuel which collided with the circumferential wall surface 26, and forms a combustible-gas-mixture layer in the about 20-ignition plug crevice 24. And stratification combustion is performed when ignition is made by the combustible gas mixture of the shape of this layer with an ignition plug 20. The combustion stabilized by this in the combustion chamber in which very superfluous inhalation air exists to a fuel can be made to perform.

[0054] Moreover, in the operating range R2 which it is between a borderline QQ1 and a borderline QQ2, the Lean

fuel oil consumption QL and an engine speed NE set up a method F2 as an operating system, and inject the fuel of an amount according to the Lean fuel oil consumption QL in 2 steps in an intake stroke and the compression stroke last stage. That is, 1st fuel injection is carried out to an intake stroke, and, subsequently to the compression stroke last stage, 2nd fuel injection is performed. The 1st injection fuel flows in a combustion chamber 10 with inhalation air, and a homogeneous lean mixture is formed in [whole] a combustion chamber 10 with this injection fuel. Moreover, as a result of performing 2nd fuel injection in the compression stroke last stage, as mentioned above, a combustible-gas-mixture layer is formed in the about 20-ignition plug crevice 24. And the lean mixture which ignition is made by the combustible gas mixture of the shape of this layer with an ignition plug 20, and occupies the whole inside of a combustion chamber 10 with this ignition flame burns. That is, in an operating system F2, weak stratification combustion of whenever [stratification] is performed rather than the operating system F1 mentioned above. By this, smooth torque change can be realized by the staging area which connects a operating range R1 and a operating range R3.

[0055] In a larger operating range R3 than a borderline QQ2, the Lean fuel oil consumption QL and an engine speed NE set up a method F3 as an operating system, and inject the fuel quantity which performed various kinds of amendments based on the theoretical-air-fuel-ratio basic fuel oil consumption QBS by the intake stroke. With the inflow of inhalation air, this injection fuel flows in a combustion chamber 10, and flows to ignition. this — the homogeneity of theoretical air fuel ratio (controlled by loading amendment by the rich air-fuel ratio with fuel concentration deeper than theoretical air fuel ratio to mention later) homogeneous in [whole] a combustion chamber 10 — gaseous mixture is formed, consequently homogeneity combustion is performed.

[0056] On the other hand, if it is P<Pc (it is "NO" at S104), since fuel pressure P is impossible for fuel injection low and sufficient in a compression stroke, a method F3 will be set up as an operating system (S108). In this way, this processing is once ended.

[0057] The flow chart of the fuel-oil-consumption control processing performed based on the operating system set up by operating-system setting-out processing mentioned above is shown in drawing 11 . This processing is processing which is set up beforehand and which is periodically performed for every crank angle.

[0058] Initiation of fuel-oil-consumption control processing reads into the working area of RAM60d the air-fuel ratio detection value Vox acquired from the signal of engine-speed NE first obtained from the signal of the accelerator opening ACCP obtained from the signal of the accelerator opening sensor 76, and the engine-speed sensor 82, the intake pressure PM obtained from the signal of the intake-pressure sensor 88, and the air-fuel ratio sensor 90 (S120).

[0059] Next, it is judged whether the operating system F3 is set up by the operating-system setting-out processing (drawing 8) mentioned above now (S126). When judged with the operating system F3 being set up, the theoretical-air-fuel-ratio basic fuel oil consumption QBS is computed from an intake pressure PM and an engine speed NE using the map of "YES") and drawing 12 beforehand set as ROM60c by (S126 (S130).

[0060] Next, heavy load loading OTP calculation processing (S140) is performed. This heavy load loading OTP calculation processing is explained based on the flow chart of drawing 13 . In heavy load loading OTP calculation processing, it is judged first whether the accelerator opening ACCP is over the heavy load loading decision value KOTPAC (S141). If it is ACCP<=KOTPAC (it is "NO" at S141), a value "0" will be set to the heavy load loading OTP (S142). That is, loading amendment of a fuel is not performed. In this way, it once comes out of heavy load loading OTP calculation processing.

[0061] On the other hand, if it is ACCP>KOTPAC (it is "YES" at S141), a value M (for example, 1> M>0) will be set to the heavy load loading OTP (S144). That is, activation of loading amendment of a fuel is set up. This loading amendment is made in order to prevent that a catalytic converter 49 is overheated at the time of a heavy load.

[0062] After the heavy load loading OTP is computed by drawing 11 at return and step S140, it is judged whether air-fuel ratio feedback conditions are satisfied (S150). For example, it is not at the "(1) start-up time. (2) The completion of warming-up is carried out. (For example, circulating-water-temperature THW>=40 degree C) Activation has completed (3) air-fuel-ratio sensor 90. (4) The value of the heavy load loading OTP is 0. It is judged whether all the conditions that are " are satisfied.

[0063] If air-fuel ratio feedback conditions are satisfied (it is "YES" at S150), calculation of the air-fuel ratio feedback multiplier FAF and its study value KG will be performed (S160). The air-fuel ratio feedback multiplier FAF is computed based on the output of the air-fuel ratio sensor 90. Moreover, the study value KG memorizes the amount of gaps from central value 1.0 in the air-fuel ratio feedback multiplier FAF. Various technique is known as the feed-back-control-of-air-fuel-ratio technique using these values is shown in JP,6-10736,A etc.

[0064] On the other hand, if air-fuel ratio feedback conditions are not satisfied (it is "NO" at S150), 1.0 is set to the air-fuel ratio feedback multiplier FAF (S170). It is steps S160 or S170, next fuel oil consumption Q is calculated like the degree type 1 (S180).

[0065]
[Equation 1]
Q <- QBS {1 +OTP+(FAF-1.0)+} (KG-1.0) alpha + beta — [Formula 1]
Here, alpha and beta are multipliers suitably set up according to the class of engine 2, or the content of control.

[0066] In this way, fuel-oil-consumption control processing is once ended. Moreover, in one case of methods F1 and F2 other than operating-system F3, i.e., operating systems, the Lean fuel oil consumption QL currently calculated at step S102 of operating-system setting-out processing (drawing 8) is set to "NO") and fuel oil consumption Q at step S126 (S126 (S190). In this way, fuel-oil-consumption control processing is once ended.

[0067] next, the electromagnetism for controlling the fuel pressure feed ratio from the high voltage fuel pump 54 to the fuel distribution tube 50 — spill valve control processing is explained based on the flow chart of drawing 14 . This processing is processing which is set up beforehand and which is periodically performed for every crank angle.

[0068] electromagnetism — the fuel oil consumption Q currently first computed by the fuel-oil-consumption control processing (drawing 11) mentioned above if spill valve control processing is started — The Lean fuel oil consumption QL currently computed as a value equivalent to an engine load at step S102 of operating-system setting-out processing (drawing 8), The fuel pressure P in the fuel distribution tube 50 detected in the engine speed NE and fuel-pressure sensor 50a which are detected by the engine-speed sensor 82 is read into the working area of RAM60d (S210).

[0069] Next, it is judged for the flag XPREEC just before automatic stay of an engine 2 whether it is "OFF" (S220). The flag XPREEC just before automatic stay is a flag which it is, and is set to "ON" when it is a condition just before automatic stay is performed here, after automatic-stay conditions are satisfied so that it may mention later.

[0070] if it is XPREEC= "ON" (it is "NO" at S220) — electromagnetism — "100%" is set as the control duty DT which sets up the clausilium period (feeding period) of the spill valve 55 (S230). the application-of-pressure stroke in which this control duty DT decreases the volume of 54f of high voltage pump houses by plunger 54e — setting — electromagnetism — the rate which the spill valve 55 has closed is shown. DT=100%, it is shown in drawing 15 — as — between the whole term of an application-of-pressure stroke — crossing — electromagnetism — the spill valve 55 has closed and it means that between the whole term of an application-of-pressure stroke is the regurgitation period Tout from the high voltage fuel pump 54 to the fuel distribution tube 50 side. That is, the condition of having adjusted the pumping speed of the high voltage fuel pump 54 to max is shown.

[0071] next, electromagnetism [in / in this control duty DT / the application-of-pressure stroke of the high voltage fuel pump 54] — it sets up as control duty showing the clausilium period of the spill valve 55 — having (S240) — once — electromagnetism — spill valve control processing is ended.

[0072] Thus, in being XPREEC= "ON", regardless of fuel oil consumption Q, the pumping speed from the high voltage fuel pump 54 to the fuel distribution tube 50 serves as max, and the fuel pressure P in the fuel distribution tube 50 rises quickly. If this condition continues, fuel pressure P will reach the setting-out injection-valve opening pressure (for example, 14.0-14.5MPa) of 54g of relief valves, and fuel blowdown to 54h of blowdown paths will come to be performed from 54g of relief valves.

[0073] On the other hand, if it is XPREEC= "OFF" (it is "YES" at S220), the feedforward term FF will be computed by the product (Kf-Q) of fuel oil consumption Q and the feedforward multiplier Kf (S250).

[0074] And the target fuel pressure Pt is computed from the map which makes a parameter the Lean fuel oil consumption QL which is equivalent to the engine load shown in drawing 16 next, and an engine speed NE (S260). This map is set up in quest of the target fuel pressure Pt which shows a suitable fuel-injection condition according to the Lean fuel oil consumption QL and an engine speed NE based on an experiment beforehand, and is memorized by ROM60c.

[0075] Next, as shown in the degree type 2, pressure deflection deltaP of the target fuel pressure Pt and the actual fuel pressure P is computed (S270).

[0076]
[Equation 2]
deltaP <- Pt - P — [Formula 2]

And Proportional DTp is computed from the product of this pressure deflection deltaP and proportionality coefficient K1 (S280). Furthermore, as shown in the degree type 3, the integral term DTi is computed based on the product (K2anddeltaP) of pressure deflection deltaP and the integral multiplier K2 (S290).

[0077]
[Equation 3]
DTi <- DTi + K2anddeltaP — [Formula 3]

In addition, "DTi" of the right-hand side expresses the integral term DTi calculated at the time of the last control period, and "0" is set up as initial value.

[0078] next, it is shown in the degree type 4 — as — electromagnetism — the control duty DT which sets up the clausilium period (feeding period) of the spill valve 55 is computed (S300).

[0079]
[Equation 4]
DT <- Ka (DTp + DTi + FF) — [Formula 4]

Here, Ka is a correction factor.

[0080] electromagnetism [in / in this control duty DT / the application-of-pressure stroke of the high voltage fuel pump 54] when the control duty DT is determined — it is set up as control duty showing the clausilium period of the spill valve 55 (S240), and this processing is once ended.

[0081] Thus, when the flag XPREEC just before automatic stay is "OFF" (it is "YES" at S220), the target fuel pressure Pt computed at step S260 is set as a suitable value in the range of 8.0-13.0MPa.

[0082] Next, automatic-stay control processing is shown in the flow chart of drawing 17 . This processing is processing which is set up beforehand and which is periodically performed for every short time. Setting out of the flag XPREEC just before automatic stay mentioned above with automatic-stay processing of an engine 2 in this processing is performed.

[0083] Initiation of this automatic-stay control processing reads the operational status for judging automatic-stay

activation first (S410). For example, the vehicle speed SPD detected from the treading-in existence of the brake pedal 78 detected from the treading-in existence of the accelerator pedal 74 detected from engine-cooling-water ** THW detected from a coolant temperature sensor 86 and the accelerator opening sensor 76, the electrical potential difference VB of a dc-battery 92, and the signal SLSW of a stop lamp switch 80 and the signal of a speed sensor 94 is read into the working area of RAM60d.

[0084] Next, it is judged whether automatic-stay conditions were satisfied from such operational status (S420). For example, the condition which is after the (1) engine's 2 warming up, and has not been overheated (engine-cooling-water ** THW is lower than the water temperature upper limit THWmax) And the condition that the (2) accelerator pedal 74 higher than the water temperature lower limit THWmin is not stepped on (accelerator opening ACCP=0 degree), (3) The condition that the charge of a dc-battery 92 is above to some extent (an electrical potential difference VB more than reference voltage), (4) The condition of getting into the brake pedal 78 (the stop-lamp-switch signal SLSW is "ON"), And when condition [of being in the condition (the vehicle speed SPD being 0 km/h) which (5) cars have stopped] (1) - (5) is satisfied altogether, it judges with automatic-stay conditions having been satisfied.

[0085] as automatic-stay conditions being abortive when at least one of the above-mentioned condition (1) - (5) is not satisfied — (— S420 — "NO — " —) — this processing is once ended. On the other hand, when the operator stopped the automobile at the crossing etc., and automatic-stay conditions are satisfied, "ON" is set as the flag XPREEC just before automatic stay by (S420 at "YES") and a degree (S430). the electromagnetism mentioned above by this — by spill valve control processing (drawing 14), it judges with "NO" at step S220 — having — step S230 — control duty DT= — setting out of 100 (%) is made. As compared with the usual operational status, fuel pressure P is made high by this.

[0086] And it is judged whether next the timer counter TC became more than the pressure-up duration Tx (S440). If it is TC<Tx (it is "NO" at S440), as shown in the degree type 5, count-up of a timer counter TC will be performed (S450), and this processing will once be ended.

[0087]

[Equation 5]

TC <- TC + dT — [Formula 5]

Here, dT is the control period of this automatic-stay control processing. That is, a timer counter TC measures the time amount after automatic-stay conditions are satisfied. And the pressure-up duration Tx is the conventional time established in order to judge whether the pressure up of the fuel pressure P performed just before automatic stay was completed in accordance with time amount. When it is set as control duty DT=100(%) mentioned above as a value of this pressure-up duration Tx, it is set up by finding time amount required for fuel pressure P fully rising by experiment.

[0088] before the pressure-up duration Tx passes after formation (it is "YES" at S420) of automatic-stay conditions, it is that processing of steps S410, S420, S430, S440, and S450 is repeated, and XPREEC= "ON" maintains — having — electromagnetism — control duty DT= to the spill valve 55 — the condition of 100 (%) continues. And halt setting out of the fuel-oil-consumption control processing stated by drawing 11 by count-up of step S450 when it became TC>=Tx (it is "YES" at S440) is made (S460). Furthermore, halt setting out of ignition control processing (graphic display abbreviation) is made (S470). Fuel injection and ignition stop by this and operation of an engine 2 stops promptly. Moreover, actuation of the high voltage fuel pump 54 is also suspended by halt of an engine 2, and check-valve 54b closes. For this reason, the inside of the fuel distribution tube 50 is sealed in the state of the high voltage fuel (however, below the setting-out injection-valve opening pressure of 54g of relief valves) which carried out pressure up from usual by control duty DT=100(%) just before the engine shutdown.

[0089] and the electromagnetism shown in drawing 14 — halt setting out should do also about spill valve control processing (S480) — the output of a control duty signal is suspended. Next, initiation of the automatic start-up control processing mentioned later is set up (S490), and this processing is once ended.

[0090] thus, fuel-oil-consumption control processing, ignition control processing, and electromagnetism, if halt setting out (S460, S470, S480) of each control of spill valve control processing and initiation setting out (S490) of automatic start-up control processing are made Henceforth, the idle state of each above-mentioned control and activation of automatic start-up control processing continue until initiation setting out of each above-mentioned control and halt setting out of automatic start-up control processing are made, even if automatic-stay conditions fall through (it is "NO" at S420).

[0091] This automatic start-up control processing is shown in the flow chart of drawing 18 . This processing is processing which is set up beforehand and which is periodically performed for every short time. Initiation of this automatic start-up control processing reads an engine operation condition for the judgment of whether to perform automatic start-up processing substantially first (S510). the data here read at said step S410, for example — the same — the electrical potential difference VB, the stop-lamp-switch signal SLSW, and the vehicle speed SPD of engine-cooling-water ** THW, the accelerator opening ACCP, and a dc-battery 92 are read into the working area of RAM60d.

[0092] Next, it is judged whether automatic start-up conditions were satisfied from such operational status (S520). For example, the condition which is after the (1) engine's 2 warming up, and has not been overheated (engine-cooling-water ** THW is lower than the water temperature upper limit THWmax) And the condition that the (2) accelerator pedal 74 higher than the water temperature lower limit THWmin is not stepped on (accelerator opening ACCP=0 degree), (3) The condition that the charge of a dc-battery 92 is above to some extent (an electrical

potential difference VB more than reference voltage), (4) The condition of getting into the brake pedal 78 (the stop-lamp-switch signal SLSW is "ON"), And when at least one of condition [of being in the condition (the vehicle speed SPD being 0 km/h) which (5) cars have stopped] (1) – (5) is not satisfied, it judges with automatic start-up conditions having been satisfied. In addition, it is not necessary to use the condition (1) – (5) same as automatic start-up conditions as the monograph affair in which it used on automatic-stay conditions, and conditions other than condition (1) – (5) may be set up. Moreover, you may extract to some of condition (1) – (5).

[0093] as automatic start-up conditions being abortive when all of above-mentioned condition (1) – (5) are satisfied — (— S520 — "NO — " —) — this processing is once ended. The above-mentioned conditions (1) "OFF" is set as the flag XPREEC just before automatic stay (S530), and the zero clear of the timer counter TC is carried out noting that automatic-stay conditions are satisfied (it is "YES" at S520), when at least one of the – (5) is no longer satisfied (S540).

[0094] And activation of automatic start-up processing is set up (S550). While the starter motor 102 drives and the crankshaft of an engine 2 rotates first by activation setting out of this automatic start-up processing, the fuel-injection control processing and ignition-timing control processing at the time of start up are performed, and automatic start up of the engine 2 is carried out. the electromagnetism shown in the fuel-oil-consumption control processing stated by <u>drawing 11</u> , ignition control processing (graphic display abbreviation), and <u>drawing 14</u> when start up was completed — spill valve control processing and processing required for other engine drives are started.

[0095] And own halt setting out of this automatic start-up control processing is made after activation setting out (S550) of automatic start-up processing (S560). Automatic start-up control processing stops by this.

[0096] Change of the fuel pressure P in the gestalt 1 of this operation is shown in the timing chart of <u>drawing 19</u> . an operator suspends a car by the idle state at a crossing etc. — time of day t0 — automatic-stay conditions — being materialized (it being "YES" at S420) — the flag XPREEC just before automatic stay is set as "ON" (S430). this — electromagnetism — control duty DT of the spill valve 55 is made 100% (S220, S230), and fuel pressure P rises quickly exceeding a fuel pressure control range (here 8–10 MPa) at the time of an idle, as a continuous line shows, and it reaches the setting-out injection-valve opening pressure (here 14–14.5 MPa) of 54g of relief valves. By this, 54g of relief valves opens temporarily, and they discharge the superfluous fuel in the fuel distribution tube 50 for 54h of blowdown paths. Then, an engine 2 is automatically stopped at the time of day t1 when the pressure-up duration Tx passed (S460, S470).

[0097] Henceforth, it is going to expand by the fuel shut up in the fuel distribution tube 50 by the remaining heat of an engine 2 being heated, and fuel pressure P tends to rise for the time being. However, fuel pressure P is maintained for a while almost uniformly with the setting-out injection-valve opening pressure of 54g of relief valves because 54g of relief valves discharges an expanded thermally fuel to 54h side of blowdown paths by open Lycium chinense slightly.

[0098] Then, thermal expansion becomes loose and lowering of the fuel pressure P in the fuel distribution tube 50 by leak of the fuel from 54g of relief valves etc. begins to appear. And as long as the engine 2 has stopped, lowering of fuel pressure P continues. However, till time of day t3, it is in the condition which has not come below the fuel pressure control range (here here 8–13 MPa), and is less than a fuel pressure control range after time of day t3.

[0099] Although fuel pressure P once rises slightly by thermal expansion as a broken line shows when lifting processing of fuel pressure P is not made like the former just before engine automatic stay, it is less than a fuel pressure control range after short time amount (time of day t2).

[0100] Among the processings mentioned above, steps S220, S230, S430, S440, and S450 are equivalent to the processing as a fuel pressure-up means. According to the gestalt 1 of this operation explained above, the following effectiveness is acquired.

[0101] Fuel pressure P is raised just before automatic stay by processing of the (b) . steps S220, S230, S430, S440, and S450. For this reason, when an engine 2 stops and a high voltage fuel is no longer fed from the high voltage fuel pump 54 after that to a fuel injection valve 22 side, as compared with the case where it stops like before with the usual fuel pressure condition, it falls from the higher fuel pressure P. For this reason, by the time it falls to the fuel pressure suitable fuel injection becomes impossible into a combustion chamber 10 by the compression stroke, the allowances of an engine halt of long duration will arise. With the gestalt 1 of this operation, it is the period when the period of time of day t1–t3 is able to perform suitable fuel injection into a combustion chamber 10 by the compression stroke as shown in <u>drawing 19</u> . With the conventional technique, it is the period when the period of time of day t1–t2 is able to perform suitable fuel injection into a combustion chamber 10 by the compression stroke.

[0102] That is, with the conventional technique, when automatic start up is carried out between time of day t2–t3, at step S104 of <u>drawing 8</u> , it will be judged with "NO" immediately after start up, and a method F3 will be set up as an operating system, and fuel injection in a compression stroke cannot be performed, but turns into intake-stroke injection. With the gestalt 1 of this operation, if it is the operational status in which it is judged with "YES" at step S104 of <u>drawing 8</u> , and stratification combustion has a possible engine 2 if automatic start up is carried out between time of day t2–t3, methods F1 or F2 can be set up as an operating system, and compression stroke injection can be performed.

[0103] Therefore, the frequency of the compression stroke injection after automatic start up can be raised, and the improvement in fuel consumption etc. can fully be attained.

as a means to raise fuel pressure P just before (b) . automatic stay — electromagnetism — control duty DT of the

spill valve 55 is made 100%, and the pumping speed of the high voltage fuel pump 54 is adjusted to max.

[0104] Thus, fuel pressure P can be made to reach sufficient high voltage condition promptly by using the range whose pumping speed of the high voltage fuel pump 54 is max. For this reason, the frequency of the compression stroke injection after automatic start up increases further, and becomes much more effective [a fuel consumption improvement].

[0105] (Ha) Fuel pressure P is raised between the pressure-up durations Tx just before . automatic stay more than the setting-out injection-valve opening pressure of 54g of relief valves by maintaining the pumping speed of the high voltage fuel pump 54 to max. By this, the opportunity of the disconnection which is 54g of relief valves which do not usually almost have the opportunity opened can be prepared.

[0106] For this reason, fixing by 54g of relief valves not being opened for a long period of time, plugging by the foreign matter, etc. can be prevented.

The gestalten 2 of the [gestalt 2 of operation] book operation differ in the die length of the pressure-up duration Tx in the gestalt 1 of said operation in step S440 of automatic-stay control processing (drawing 17). Other configurations are the same as the gestalt 1 of said operation. namely, — until [after going up more than the setting-out injection-valve opening pressure of 54g of relief valves, not being a request and only becoming about the fuel pressure P in front of automatic stay more than the setting-out injection-valve opening pressure of 54g of this relief valve] a certain amount of [the fuel in the fuel distribution tube 50] amount from 54g of relief valves is discharged — electromagnetism — the control duty DT of the spill valve 55 is maintained to 100%. For this reason, the pressure-up duration Tx is made longer than the case of the gestalt 1 of said operation.

[0107] By this, as Period Tmax shows to the timing chart of drawing 20 , disconnection of 54g of relief valves is repeated repeatedly, the fuel of a large quantity is sent to the fuel distribution tube 50 from the high voltage fuel pump 54, and the condition that that part is discharged from 54g of relief valves by 54h of blowdown paths is repeated.

[0108] According to the gestalt 2 of this operation explained above, the following effectiveness is acquired.

(**) . — (**) of the gestalt 1 of said operation − (Ha) effectiveness are produced.

Even after raising (b) ., thus fuel pressure P more than the setting-out injection-valve opening pressure of 54g of relief valves, the processing which raises fuel pressure P more than the setting-out injection-valve opening pressure of 54g of relief valves is made to continue for the time being. By this, 54g of relief valves is opened just before automatic stay repeatedly, a fuel is fed by the large quantity to the fuel distribution tube 50 side, and the fuel temperature in the fuel distribution tube 50 falls just before automatic stay.

[0109] For this reason, in connection with the temperature of a fuel rising during automatic stay of an engine 2, maintenance of the fuel pressure P by thermal expansion will be performed. From this, the frequency of the compression stroke injection after automatic start up can be raised further, and the improvement in fuel consumption etc. can be attained more effectively.

[0110] The gestalt 3 of the [gestalt 3 of operation] book operation judges activation of automatic stay by the monitor of fuel pressure P, and performs processing of drawing 21 instead of automatic-stay control processing (drawing 17) of the gestalt 1 of said operation. Other configurations are the same as the gestalt 1 of said operation. Moreover, in automatic-stay control processing of drawing 21 , it is only that processing of steps S1440, S1442, and S1444 differs from automatic-stay control processing (drawing 17) of the gestalt 1 of said operation. Other steps are performing the same processing as the step in drawing 17 with the same triple figures under a step number.

[0111] that is, automatic-stay conditions are satisfied (it is "YES" at S1420), and "ON" sets it as the flag XPREEC just before automatic stay — having (S1430) — it is judged whether next the timer counter TC became more than the time limit Ty (S1440). The time limit Ty is judgment time amount established since it shifts to automatic stay, without waiting for the pressure up of fuel pressure P by a certain cause when the pressure up of fuel pressure P is late here.

[0112] If it is TC<Ty (it is "NO" at S1440) next, it will be judged whether it is under the pressure-up judging pressure value Pr with which fuel pressure P was set as the range to the setting-out injection-valve opening pressure (for example, 14MPa(s)) of the upper limit (here for example, 13 MPa(s)) of a fuel pressure control range − 54g of relief valves (S1442).

[0113] If it is P<Pr (it is "YES" at S1442), as shown in said formula 5, count-up of a timer counter TC will be performed (S1450), and this processing will once be ended.

[0114] before the time limit Ty passes after formation (it is "YES" at S1420) of automatic-stay conditions, it is that processing of steps S1410, S1420, S1430, S1440, S1442, and S1450 is repeated, and XPREEC= "ON" maintains — having — electromagnetism — control duty DT= to the spill valve 55 — the condition of 100 (%) continues.

[0115] And by lifting of fuel pressure P, if it becomes P>=Pr (it is "NO" at S1442), the value of the time limit Ty will be set as a timer counter TC (S1444), and halt setting out of fuel-oil-consumption control processing (drawing 11) will be made (S1460). Furthermore, halt setting out of ignition control processing is made (S1470). Fuel injection and ignition stop by this and operation of an engine 2 stops promptly. Also suspending actuation of the high voltage fuel pump 54 by halt of an engine 2, check-valve 54b closes. For this reason, the inside of the fuel distribution tube 50 is sealed in the state of the high voltage fuel (however, below the setting-out injection-valve opening pressure of 54g of relief valves) which carried out pressure up from usual by control duty DT=100(%) just before the engine shutdown. and electromagnetism — halt setting out should do also about spill valve control processing (drawing 14) (S1480) — the output of a control duty signal is suspended. Next, initiation of automatic start-up control

processing (drawing 18) is set up (S1490), and this processing is once ended.

[0116] Among the processings mentioned above, steps S220, S230 (drawing 14), S1430, and S1442 are equivalent to the processing as a fuel pressure-up means. According to the gestalt 3 of this operation explained above, the following effectiveness is acquired.

[0117] (b) of the gestalt 1 of the (b) . aforementioned implementation and the effectiveness of (b) are produced. Since pressure up is directly supervised with the value of the (b) . fuel pressure P, automatic-stay timing can be further caught to accuracy. Therefore, automatic stay can be performed at an early stage, and the improvement in fuel consumption etc. can be attained more effectively.

[0118] (Ha) Also when lifting of fuel pressure P is slow, it can be made to shift to automatic stay certainly by a certain cause, since the . time limit Ty is formed.

The gestalt 4 of the [gestalt 4 of operation] book operation is performing pressure up of fuel pressure P by carrying out increment amendment of the target fuel pressure Pt just before automatic stay rather than making control duty DT 100%. for this reason, the electromagnetism of the gestalt 1 of said operation — processing of drawing 22 is performed instead of spill valve control processing (drawing 14). Other configurations are the same as the gestalt 1 of said operation. moreover, the electromagnetism of drawing 22 — steps S1210, S1250, S1260, S1270–S1300 other than step S1262 of spill valve control processing and S1264 and each processing of S1240 are performing the same processing as the step in drawing 14 with the same triple figures under a step number.

[0119] namely, the map shown in drawing 16 based on the Lean fuel oil consumption QL and an engine speed NE to the target fuel pressure Pt — computing (S1260) — it is judged for the flag XPREEC just before automatic stay whether it is "OFF" (S1262).

[0120] If it is XPREEC= "OFF" (it is "YES" at S1262), pressure deflection deltaP with the actual fuel pressure P will be computed using the target fuel pressure Pt computed at step S1260 (S1270). And Proportional DTp is computed from the product of this pressure deflection deltaP and proportionality coefficient K1 (S1280), and further, as shown in said formula 3, the integral term DTi is computed based on the product (K2anddeltaP) of pressure deflection deltaP and the integral multiplier K2 (S1290).

[0121] and it was shown in said formula 4 — as — electromagnetism — electromagnetism [in / the control duty DT which sets up the clausilium period (feeding period) of the spill valve 55 is computed (S1300), and / in this control duty DT / the application-of-pressure stroke of the high voltage fuel pump 54] — it is set up as control duty showing the clausilium period of the spill valve 55 (S1240), and this processing is once ended.

[0122] On the other hand, if it is XPREEC= "ON" (it is "NO" at S1262), as shown in the degree type 6, loading amendment of the target fuel pressure Pt will be carried out (S1264).

[0123]
[Equation 6]
Pt <- Pt + Pi — [Formula 6]
Here, Pi expresses loading correction value.

[0124] Then, pressure deflection deltaP with the actual fuel pressure P is computed using the target fuel pressure Pt which carried out loading amendment at step S1264 (S1270). electromagnetism [in / the control duty DT is computed by steps S1280–S1300 being performed below, and / in this control duty DT / the application-of-pressure stroke of the high voltage fuel pump 54] — it is set up as control duty showing the clausilium period of the spill valve 55 (S1240), and this processing is once ended.

[0125] Therefore, in XPREEC= "ON" (it is "NO" at S1262), fuel pressure P is adjusted so that it may become high voltage from usual. Among the processings mentioned above, steps S1262 and S1264 and steps S430, S440, and S450 (drawing 17) are equivalent to the processing as a fuel pressure-up means, and steps S1210, S1250, S1260, S1270–S1300 and S1240 are equivalent to the processing as a fuel-pressure control means.

[0126] According to the gestalt 4 of this operation explained above, the following effectiveness is acquired.
The effectiveness of (b) of the gestalt 1 of the (b) . aforementioned implementation is produced.
[The gestalt of other operations]
– In the gestalten 1–4 of the aforementioned implementation, the pressure-up duration Tx or the time limit Ty may be set up according to the operational status of an engine 2.

[0127] – In the gestalt 4 of the aforementioned implementation, target fuel pressure Pt by which loading amendment is carried out at step S1264 may be made into the value more than the setting-out injection-valve opening pressure of 54g of relief valves, valve opening of 54g of relief valves may be performed, and plugging of fixing or a foreign matter may be prevented. Furthermore, after reaching the value more than the setting-out injection-valve opening pressure whose actual fuel pressure P is 54g of relief valves, for a while, loading amendment of the target fuel pressure Pt in step S1264 is continued, and it is [lowering / of the fuel in the fuel distribution tube 50 / temperature] good in drawing.

[0128] – In automatic-stay control processing (drawing 17 , drawing 21) of the gestalten 1 and 3 of the aforementioned implementation, although ignition control processing halt setting out (S470, S1470) was performed, since a revolution of an engine 2 suspends only a halt of fuel injection, it is not necessary to perform ignition control processing halt setting out.

[0129] As mentioned above, although the gestalt of operation of this invention was explained, it appends that it is a thing including the following gestalten to the gestalt of operation of this invention.
(1) Cylinder-injection-of-fuel type internal combustion engine control unit characterized by having an automatic-stay authorization means to permit activation of said automatic stay in the configuration of . claims 1 and 2 or four

publications when the fuel pressure by the side of a fuel injection valve rises to reference pressure with said fuel pressure-up means.
[0130] (2) Cylinder-injection-of-fuel type internal combustion engine control unit characterized by having an automatic-stay authorization means to permit activation of said automatic stay in the configuration of . claims 1 and 2 or four publications when the pressure-up processing by said fuel pressure-up means goes through the conventional time.

[Translation done.]

DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
[Drawing 1] The outline block diagram of a cylinder-injection-of-fuel type internal combustion engine in the gestalt 1 of operation.
[Drawing 2] The block diagram of the cylinder-injection-of-fuel type internal combustion engine control system of the gestalt 1 of operation.
[Drawing 3] The horizontal sectional view of the cylinder head in the gestalt 1 of operation.
[Drawing 4] The top view of the top face in the piston of the gestalt 1 of operation.
[Drawing 5] The X-X sectional view in drawing 3 .
[Drawing 6] The Y-Y sectional view in drawing 3 .
[Drawing 7] The configuration explanatory view of the fuel feed system in the gestalt 1 of operation.
[Drawing 8] The flow chart of operating-system setting-out processing of the gestalt 1 of operation.
[Drawing 9] The map configuration explanatory view for calculating the Lean fuel oil consumption QL with the gestalt 1 of operation.
[Drawing 10] The map configuration explanatory view for setting up an operating system with the gestalt 1 of operation.
[Drawing 11] The flow chart of fuel-oil-consumption control processing of the gestalt 1 of operation.
[Drawing 12] The map configuration explanatory view for calculating the theoretical-air-fuel-ratio basic fuel oil consumption QBS with the gestalt 1 of operation.
[Drawing 13] The flow chart of the heavy load loading OTP calculation processing performed with the gestalt 1 of operation.
[Drawing 14] the electromagnetism of the gestalt 1 of operation — the flow chart of spill valve control processing.
[Drawing 15] the electromagnetism in the gestalt 1 of operation — the timing chart which shows an example of spill valve control.
[Drawing 16] The map configuration explanatory view for asking for the target fuel pressure Pt with the gestalt 1 of operation.
[Drawing 17] The flow chart of automatic-stay control processing of the gestalt 1 of operation.
[Drawing 18] The flow chart of automatic start-up control processing of the gestalt 1 of operation.
[Drawing 19] The timing chart which shows an example of control of the fuel pressure P in the gestalt 1 of operation.
[Drawing 20] The timing chart which shows an example of control of the fuel pressure P in the gestalt 2 of operation.
[Drawing 21] The flow chart of automatic-stay control processing of the gestalt 3 of operation.
[Drawing 22] the electromagnetism of the gestalt 4 of operation — the flow chart of spill valve control processing.
[Description of Notations]
2 [The cam for pumps,] — An engine, 2a — A cylinder, 2b — The cam shaft for exhaust valves, 2c — 4 [— Combustion chamber,] — A cylinder block, 6 — A piston, 8 — The cylinder head, 10 12a — The 1st inlet valve, 12b — The 2nd inlet valve, 14a — The 1st inlet port, 14b [— Ignition plug,] — The 2nd inlet port, 16 — An exhaust valve, 18 — An exhaust port, 20 22 — A fuel injection valve, 24 [— Inlet manifold,] — A crevice, 26 — A circumferential wall surface, 30 30a — The 1st inhalation-of-air path, 30b — The 2nd inhalation-of-air path, 32 — Surge tank, 34 — An air-current control valve, 36 — A shaft, 37 — Negative pressure type actuator, 40 [— Throttle valve,] — An air intake duct, 42 — An air cleaner, 44 — A motor, 46 46a — A throttle opening sensor, 48 — An exhaust manifold, 49 — Catalytic converter, 50 [— High voltage fuel path,] — A fuel distribution tube, 50a — A fuel-pressure sensor, 54 — A high voltage fuel pump, 54a 54b — A check valve, 54c — A low voltage fuel path, 54d — Pump cylinder, 54e — A plunger, 54f — A high voltage pump house, 54g — Relief valve, 54h— a blowdown path, a 54i— gallery, and 55 — electromagnetism — a spill valve and 56 — a fuel tank — 58 — A feed pump, 58a — A filter, 58b — Pressure regulator, 60 — ECU, 60a — A bi-directional bus, 60 b—CPU, 60 c—ROM, 60 d—RAM, 60e — Backup RAM, 60f — Input circuit, 60g — An output circuit, 74 — An accelerator pedal, 76 — Accelerator opening sensor, 78 [— A cylinder distinction sensor 86 / — A coolant temperature sensor, 88 / — An intake-pressure sensor, 90 / — An air-fuel ratio sensor, 92 / — A dc-battery, 94 / — A speed sensor, 100 / — An ignitor, 102 / — Starter motor.] — A brake pedal, 80 — A stop lamp switch, 82 — A rotational frequency sensor, 84

[Translation done.]